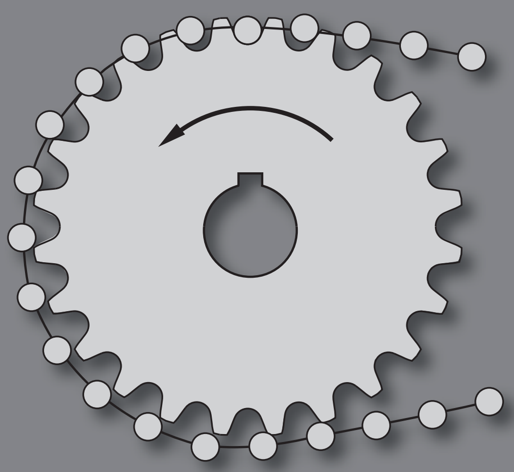
G - Analysis of chain damage



G - Analysis of chain damage

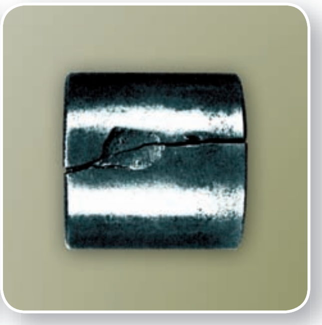
Analysis of chain damage

Causes and remedies

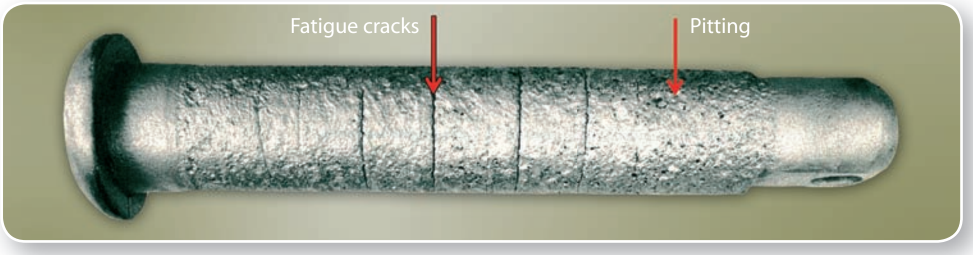
For nearly a century, chains have been used with outstanding success for a wide variety of drive and conveyor applications. However, difficulties do occasionally arise and you wil be called on to suggest corrective measures. This chapter has been prepared to assist you in these situations.

Our goal in this chapter is to illustrate and explain the effects of various operating conditions on chain life so that you will be better equipped to recognize and diagnose chain problems on the spot. This ability will be of value to you and the chain user.

Of course, the plant engineering staff and laboratory facilities are always available to provide whatever technical assistance may be required for problem analysis or solution.



Pin breakage
from corrosion fatigue



When a load is applied to chain, the joint clearance accumulates between the "back side" of the pin and the inner wall of the chain link or bushing. The area of the pin thus exposed is susceptible to corrosive attack and pitting if it is unprotected and the chain operates in the presence of water, acid-base compounds, or materials that produce acids when combined with water.

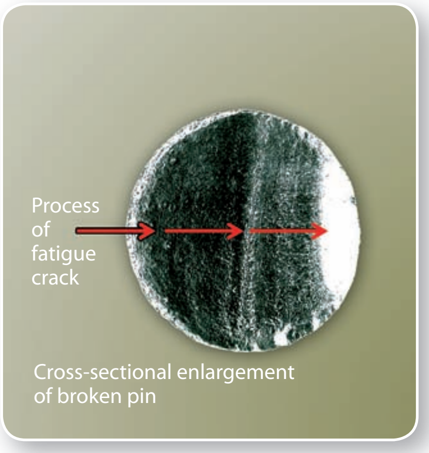
Like any structural member, chain pins bend minutely under load. Under this condition, the surface on the back side of the pin is stretched, or put in tension. If the pin has been pitted by corrosive attack, each pit becomes a point of stress concentration.

The illustration above shows how bending can eventually cause fatigue cracks to start at the points of stress. These cracks can progress until the pin finally breaks during a load cycle.

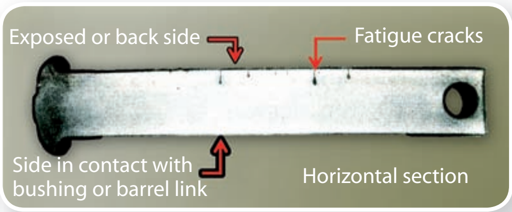
A less advanced stage of corrosion pitting is illustrated at the bottom. Note the areas on the pins that were in contact with sidebars and thereby protected from attack.

Protective coatings, such as a water-resistant lubricant or cadmium plating, are often effective in preventing corrosive attack. When conditions are severe, corrosive-resistant materials such as stainless steel may be most effective.

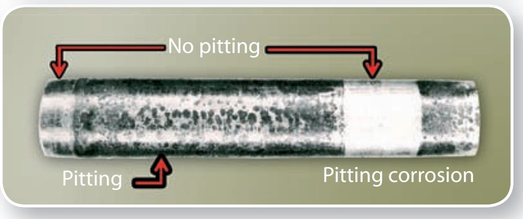
The illustrations at the top show an advanced stage of corrosive attack and depict the entire process of corrosion fatigue-pitting, cracking and fracture. The pins shown were removed from a conveyor which handled an acid-producing material. In applications like this, it is sometimes possible to reduce the degree of corrosiveness or acidity, in addition to providing a protective coating for the pins.
To find the most effective deterrent to corrosion fatigue, all aspects of load, speed, material handled, etc., must be recognized and evaluated.



Cross-sectional enlargement of broken pin



Horizontal section



Pitting corrosion

CHAIN DAMAGE

Pin wear

from abrasion, inadequate or ineffective lubrication

PS. or too high pressure per mm2. In this case increase rotation surface to reduce pressure per mm2. This if greasing is not possible.

Wear is a normal condition that is expected whenever there is motion and contact between two parts, such as the articulation of a chain pin in a link barrel or bushing.

The presence of abrasives or an ineffective oil film between the bearing surfaces can result in an accelerated rate of wear. For example, the pin shown above was removed from a power transmission chain exposed to an atmosphere heavily loaden with sand and dirt. These abrasives penetrated the chain joints, causing rapid pin wear, and a substantial reduction in the useful life of the chain.

Under conditions like this, periodic removal of the chain, through cleaning, and careful re-lubrication will usually prolong chain life. Sometimes, power transmission drive chains can be enclosed in a sheet-metal casing which not only offers protection from abrasives but, at the same time, provides a means for effective chain lubrication.

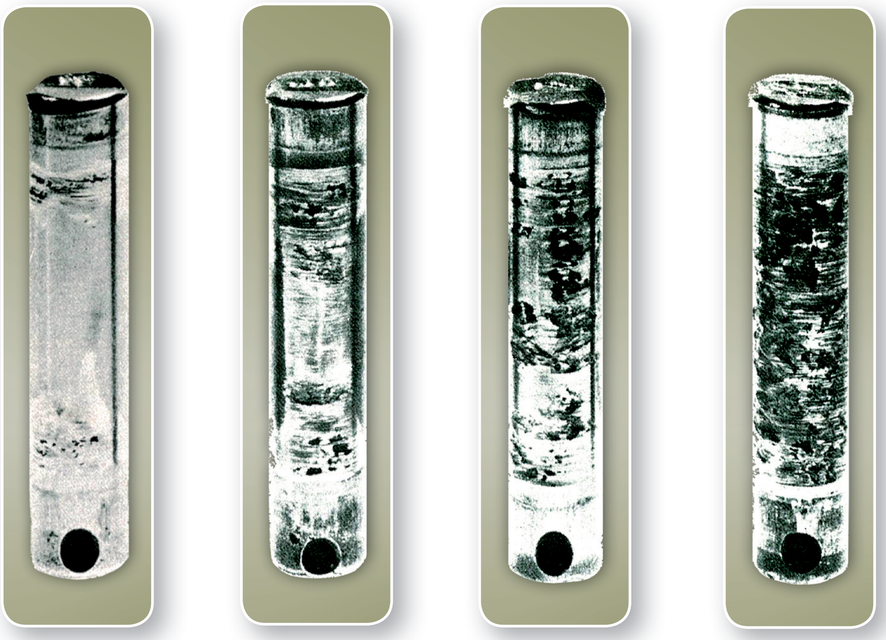
Baffles or chields can sometimes be employed to protect conveyor chains from direct exposure to abrasives. Some large conveyor chains can be equipped with lubricated pins (pins with pressure-lubrication fittings) so that abrasives can be flushed from the chain joints at regular intervals. At other times, it may be desirable to re-pin the chain, using hard-chrome plated pins for greater wear resistance.

Unusual pin wear is often the result of inadequate or ineffective lubrication. In these cases, the film of oil between the bearing surfaces is not sufficient to properly prevent metal-to-metal contact or flush the chain joint. As a result, the pin can be abraded in a manner similar to that shown in the photo. Rapid pin wear from this cause can usually be overcome by an improved method of lubrication.

A thorough analysis of conditions will often suggest the most practical and effective measure for reducing pin wear and increasing chain life.

Pin galling

from inadequate oil film between bearing surfaces



INTENSITY OF GALLING

Incipient Galling	**Moderate Galling**	**Heavy Galling**	**Severe Galling**

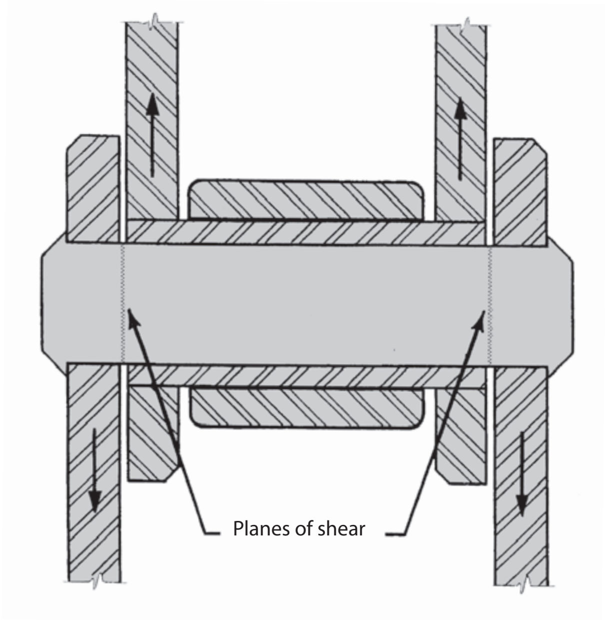
The primary purpose of lubrication (for chains or any mechanical device) is to provide an effective film of oil between bearing surfaces in order to prevent direct metal-to-metal contact.

Chain pins can become galled if the oil film is not adequate to support the load, or for some reason ceases to do so. The intensity of galling, of course, depends upon the degree and duration of the metal-to-metal contact.

Operation for very short periods under unusually severe load conditions, or very high speeds could cause incipient or moderate galling. This type of galling may not have an appreciable effect on chain life, and the condition may not worsen if precautions are taken to avoid a recurrence.
More intense forms of galling may be observed when heavily loaded chains operate at either very high or very low speeds. At high speeds, pin galling could occur because of insufficient time between load cycles for an adequate film of oil to form. At very low speeds, high bearing pressures may squeeze the lubricant out of the joint and the sustained heavy load prevent it from re-forming between the bearing surfaces. Some change in load and/or speed will often permit the lubricant to function effectively thereby reducing the tendency of the pins to gall.
In some situations, a more effective method of lubrication can be used.

Pin shear

from sudden, severe overload



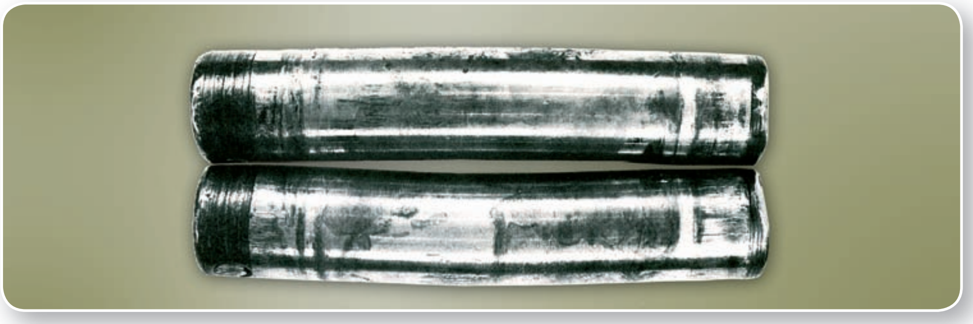
On other pages we have noted that chain pins (depending on the situation) may: wear, break, gall, corrode, or bend. In other circumstances more rarely encountered, a chain pin may shear.

If pin chear occurs, it can usually be traced to a sudden, abnormally severe overload. Accidental jam-ups would be an expectable cause. In the case of the pins illustrated, a severe shock load was applied to an already heavily loaded drive, causing the pins to shear.

Pin shear is characterized by a rounded, reasonably smooth cross-sectional surface as shown in the photos at right. Shearing occurs at the points illustrated by the sketch above.

Since pin shear can be traced to an abnormal load condition, the cause can usually be determined. Precautionary measures can then be taken to avoid a recurrence.

Pin bending
from overloading



Pin bending usually results from a sudden load application heavy enough to cause permanent deformation, but not heavy enough to shear the pin.

This condition has been seen when a drive chain has been operated beyond its design capacity. It has also been observed in heavily loaded conveyor chains where the addition of a sudden shock load exceeded the chains normal working capacity.

In situations like this, corrective measures can often be taken to reduce either the severity of loading or the probability of overloads.

The pins of conveyor chains exposed to high temperatures may deform if heavy loads exist. This tendency can often be overcome by shielding the chain from direct exposure to the heat. Baffles are commonly used for this purpose. Under extreme conditions, a protective water jacket or a heat-resisting alloy chain can be used.

Bent pins result in a loss of chain pitch uniformity and pair joint articulation. These conditions can impose additional stresses on the chain and increase the rate of sprocket tooth wear. Consequently, in addition to correcting the cause of pin bending, it may be desirable to replace the bent pins or the entire chain.

Pin and bushing erosion

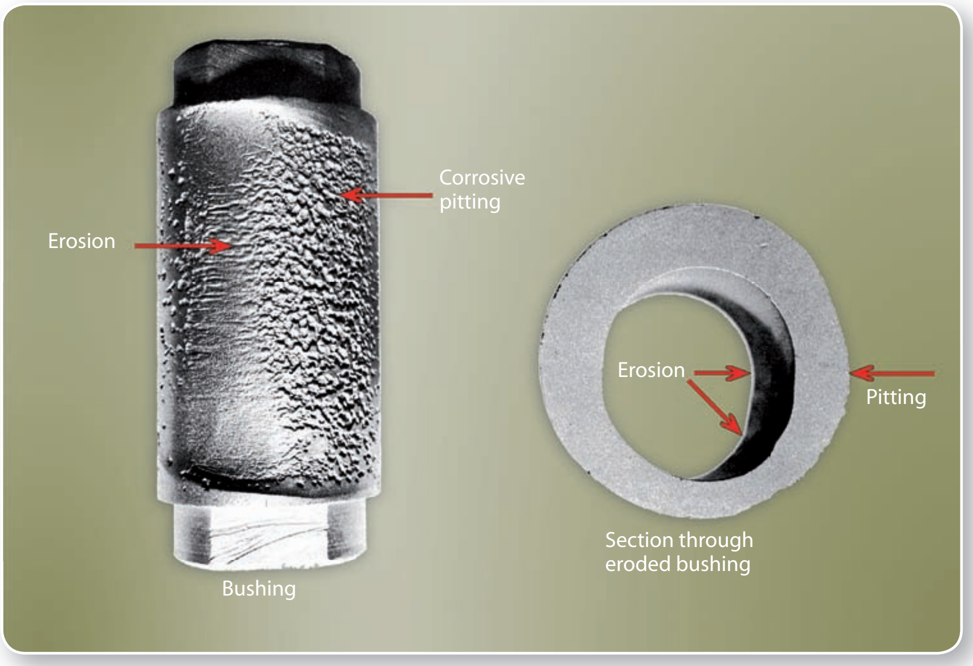
water, abrasive and corrosive materials

The erosion of chain joint bearing surfaces can occur when chains handle abrasive and corrosive materials in the presence of water. The degree and rate of erosion, of course, depend upon the severity of conditions and rarely reach the extreme stage illustrated above.

Erosion is a continuing process wherein the abrasive impurities and the water combine to literally wash away steel particles from the bearing surfaces. This eroding action gradually reduces the cross-sectional areas of the pins and bushings, as well as their load carrying capacity.

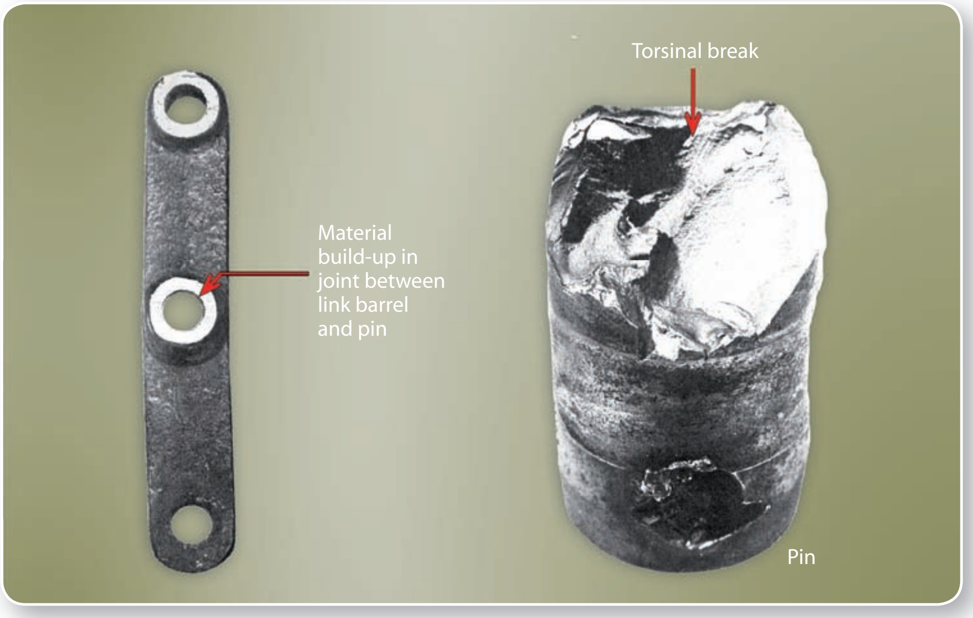
Some protective coatings can be effective in retarding corrosive attack and abrasive wear. In some cases, stainless steel pins and bushings can be effective in combating erosion. Sometimes it may even be possible to reduce the degree of acidity, in addition to providing a protective coating for the joint parts.

A thorough evaluation of the effect of each factor contributing to erosion will indicate the most practical corrective measure for extending chain life.



Chain joint seizure

from corrosion, galling, or packing of joints



Chain joints are susceptible to freezing (or binding) if the bearing surfaces become severely corroded or galled, or if the clearances between the joint parts become packed with a material that tends to harden.

In moderate cases, the joint components may break loose when the chain articulates over the sprockets. In the event of a rigid joint seizure a torsional pin break could occur, or the sidebar pitch holes could tear.

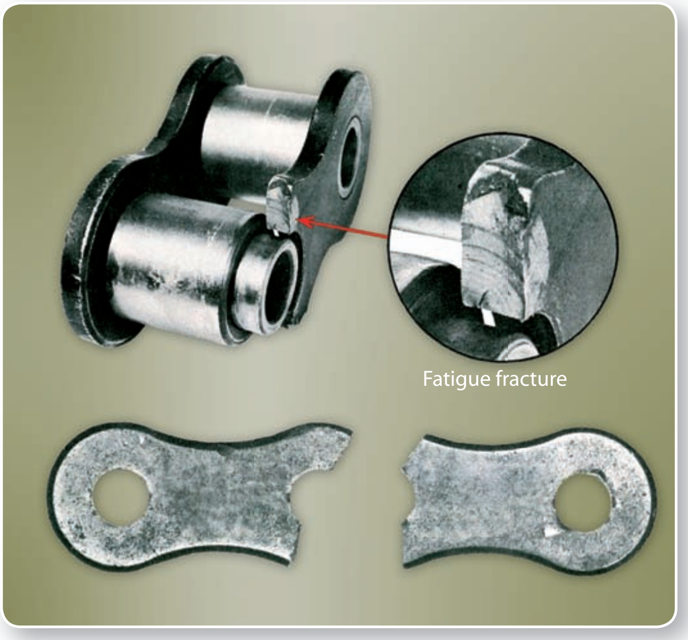
A protective coating may be useful in preventing rust, and possible freezing, when chains are subject to intermittent operation or long periods of idleness. In these cases, occasional operation during idle periods will substantially reduce chances of binding.

Corrosion-resistant pins and bushings may be preferred in severe cases.

Similarly, a lubricant will often retard penetration of the joint clearances by materials which pack and harden. Some of the larger chains can be equipped with pins having pressure-lubrication fittings so that foreign materials can be flushed from the joints. In some other cases, the preferred method for prolonging chain life may be frequent removal, thorough cleaning, and careful re-lubrication.

Chain joints can also freeze due to galling if chains are operated beyond their limiting speeds.

Sidebar fatigue at pitch holes
from severe cyclic loading



Sidebar fatigue occurs when the frequency and magnitude of stress-on, stress-off cyclic loading causes the sidebar material to reach the limit of its fatigue before the chain is worn out.

A sidebar fatigue failure begins with a very minute crack at the edge of a pitch hole. With repeated load cycles, the crack gradually progresses outward until the sidebar is sufficiently weakened to permit complete fracture.
Consequently, a fatigue failure is characterized by a series of concentric, curved lines in an area having the appearance of a brittle fracture.

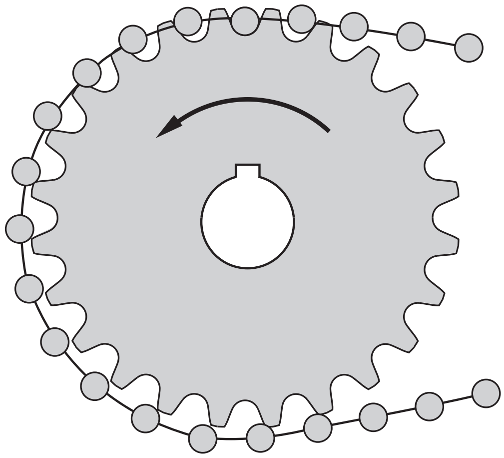
Sometimes, it is possible to reduce the magnitude of chain loading; however, a thorough analysis of all operating conditions is usually required to find an effective solution.

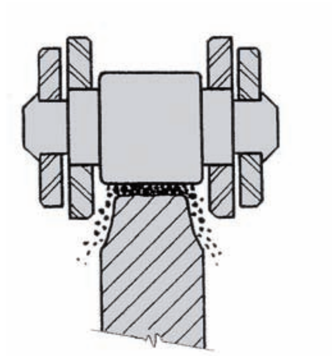
Roller fatigue
from corrosion, galling, or packing of joints

Impact of some magnitude takes place whenever chain rollers contact sprocket teeth. If operating conditions involve heavy loads and high speeds, the shock of tooth-meshing can be severe. Sometimes the impact is great enough to induce high stresses in the surfaces of the rollers. Under repeated heavy blows, these stresses could cause fatigue cracks to start.
Ultimately, the rollers could break due to metal fatigue.

Roller fatigue can often be overcome by a reduction in load and/or speed.

Crushed rollers or bushings
from high load concentration





Sprockets with mud relief grooves

Due to pitch elongation, a severely worn chain may not seat properly on its sprockets. As illustrated in the above figure, some of the rollers (or bushings) may contact the tips of the sprocket teeth. This can impose loads large enough to crush the rollers or bushings. When this type of engagement is observed, the chain should be replaced to prevent undue sprocket damage.

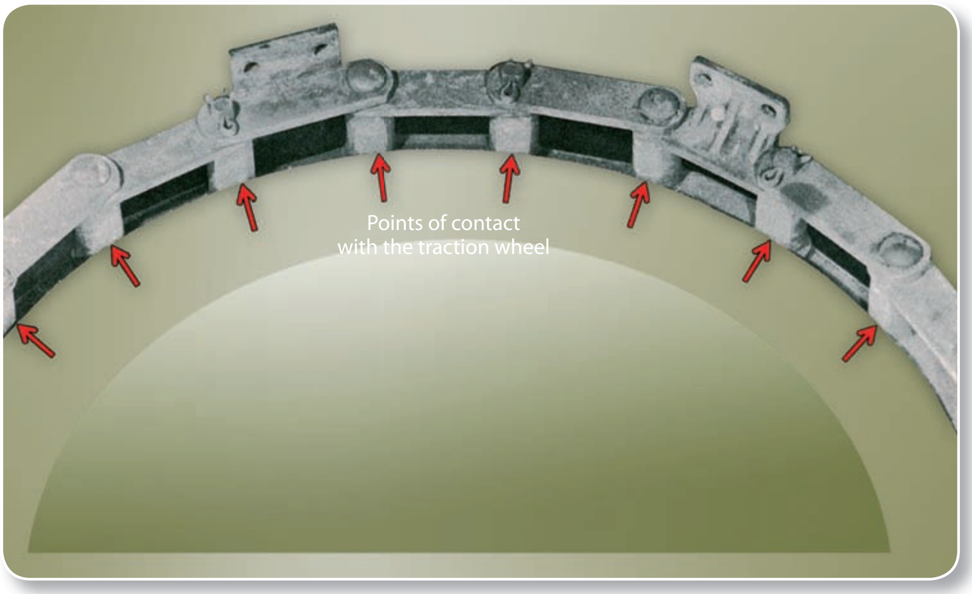
Improper engagement can similarly occur when a new chain is operated on severely worn sprockets. Rollers can be crushed in the same manner as described above. Severely worn sprockets should be replaced at the same time as the chain if full service life is to be received.

Rollers can also be crushed if rocks or other hard materials build up or become trapped in the gaps between sprocket teeth. When chains operate in or near mud, rocks, etc., mud relief sprockets can often be used to protect the rollers from severe pressure and damage. The reliefs, located below and on each side of the tooth pockets, provide a means of escape for foreign objects so that they can be ejected by the rollers as they seat on the sprocket.

A severe overload, due to an accidental jam-up, can also crush rollers or bushings. In these cases, corrective measures can often be taken to guard against a recurrence of the accident.

Link wear

from slippage between traction wheel and chain



For bucket elevators and other applications, lower cost traction wheels can often be used instead of sprockets. However, adequate tractive force between chain and drive wheel is essential for efficient operation.

The chain link shown above was used in a bucket elevator handling a hard, abrasive material. The severe wear shown on this link was caused by slippage during periods of peak loading. At these times, the tractive force was not sufficient to drive the chain efficiently.
Surge loads could be expected to cause slippage between chain and traction wheels. Chain slippage in a bucket elevator can often be corrected by a more uniform, closely regulated feed. Care should be taken to maintain proper takeup adjustement, and to avoid overloading the chain with takeup tension. Sometimes, slippage can best be corrected by replacing the traction wheels by sprockets, thereby providing a means of positive engagement with the chain.

Abnormal chain, sprocket, or track wear
from misalignment

Unusual wear patters on chain often indicate a condition of misalignment which can cause severe chain damage. The most common types of misalignment are:

- Shafts not parallel
- Sprockets not in line with one another
- Sections of conveyor trackage not aligned.

Under some conditions of misalignment, one side of the chain is overloaded: under other conditions, the chain is forced to twist or distort as it moves from one sprocket to another.

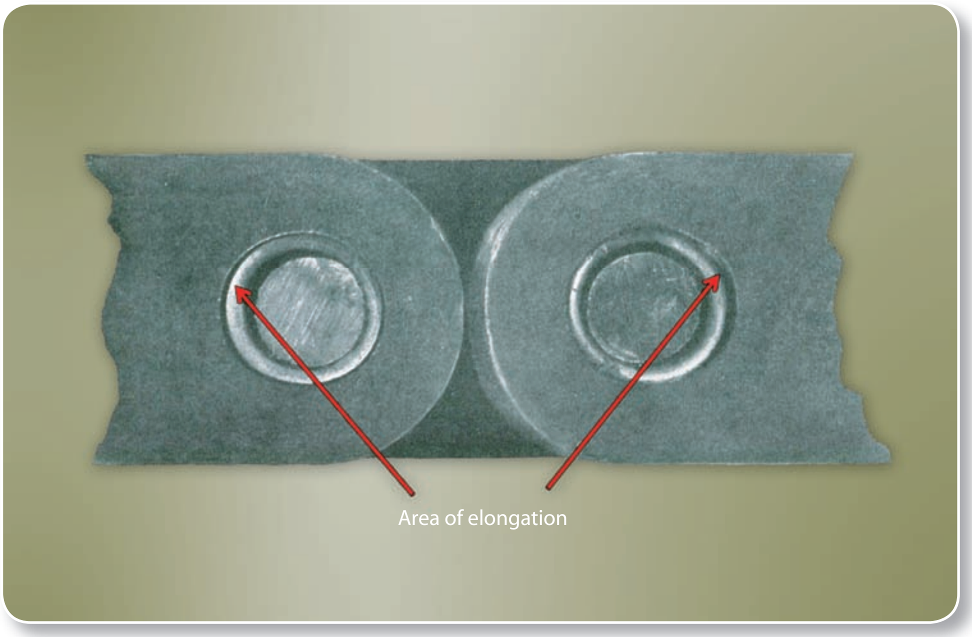
Unequal chain loading can cause pin galling, sidebar failure, or rapid wear. The photo above vividly illustrates galling as a result of misalignment. A perceptible increase can be seen in the severity of galling toward the end of the pins where the overload was greatest.

Misalignment can also cause scrubbing between sidebars, or between sidebars and sprocket teeth, as illustrated by the chain link photo above. This kind of action causes side cutting, increased frictional loads, and in some cases, the loss of proper fit between parts.

Misalignment conveyor tracks can produce unequal wear in the chain. The curvature (or camber) that results, induces a tendency in the chain to run toward one side of the track or trough. This can increase the frictional load and cause damage to the tracks and the pin ends.

The best precaution against chain damage from misalignment is frequent inspection of drives and conveyors. Prompt adjustments can then be made when signs of unusual wear are observed.

Chain elongation (or stretch)
from tensile overloads



This type of elongation involves plastic deformation wherein the sidebar material has been loaded beyond its yield point, but not beyond its ultimate strength. Consequently, the sidebars are permanently stretched, but do not fracture.

If pitch elongation is severe, the chain will no longer mesh properly with the sprockets. Quite often, too, an excessive tensile load will cause other damage, such as cracked bushings, crushed rollers, bent pins, or loss of fit between parts, which can lead to premature failures.

Chain elongation from tensile overload may result when equipment is forced to operate beyond its design capacity, when accidental jam-ups occur, and similar causes.
The effect of this type of overload is illustrated above.

Corrective measures can often be employed to prevent the recurrence of overload. Sometimes a shock-absorbing device can be used so that overloads will not be transmitted to the chain.

View on products in our range
Special customer-made

(please consult us with drawings and samples)

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